INL's unparalleled Advanced Test Reactor was recently upgraded with new, state-of-the-art control systems to improve reliability, safety and increase capabilities.

System upgrades at Advanced Test Reactor help ensure nuclear energy research continues at Idaho National Laboratory

By Craig Wise, *ATR technical writer/editor*

First operational in 1967, the Advanced Test Reactor (ATR) is a first-of-its-kind materials test reactor. Located on Idaho National Laboratory's desert Site, this reactor remains at the forefront of nuclear science, producing extremely high neutron irradiation in a relatively short time span. The Advanced Test Reactor is also the only U.S. reactor that can replicate multiple reactor environments concurrently.

Idaho National Laboratory and the Department of Energy recently invested more than $13 million to replace three of ATR's instrumentation and control systems. The new systems offer the latest software and technology advancements, ensuring the availability of the reactor for future energy research. Engineers and project managers successfully completed the four-year project in March while the ATR was in a scheduled maintenance outage.

"These new systems represent state-of-the-art monitoring and annunciation capabilities," said Don Feldman, ATR station manager. "They are comparable to systems currently used for advanced reactor designs planned for construction in the U.S. and in operation in some foreign countries."

The new instrumentation and control systems at the ATR simulator are shown at left; the predecessor systems are shown at right.

Contributing to nuclear energy innovation

"ATR has used digital control systems for many years," said Mike Love, director of ATR Operations, "and we continue to lead the industry in state-of-the-art control systems. The latest investment increases plant reliability and safety while increasing the capabilities of our operators, so we can continue assisting universities and private agencies with their research."

In 2007, the Department of Energy designated the Advanced Test Reactor as a National Scientific User Facility. This designation means that ATR directly contributes to the development of improved products and processes that increase U.S. scientific competiveness. Researchers benefit from the ATR's intense neutron and gamma radiation capabilities, which significantly reduces the length of time that nuclear fuels and materials experiments need to remain in the reactor.

New system benefits

The three replacement systems—distributed control system (DCS), console display system (CDS), and the annunciator system—help the reactor's operators and engineers maintain stable and efficient nuclear reactions for materials and fuel experiments. These instrumentation and control systems automate important reactor process functions as well as monitor and display vital information to reactor staff in the control room.

The replacement systems provide the same primary functionality as their predecessors, but they incorporate industry enhancements that have become available in recent years. The new systems offer leading-edge electronic and computing technology, including improved network communication speed, high-resolution LCD screens, and improved trending and reporting capabilities. In addition, the project incorporated stringent environmental and seismic qualifications that help to ensure the survival of the reactor's support systems in the unlikely event of an earthquake.

Distributed control system

The DCS is a computerized system that provides automatic control and alarm functions for many of the reactor's subsystems. For example, this

system maintains the reactor's core temperature by monitoring and automating the flow of the primary and secondary coolant pumps, allowing the controlled nuclear reactions to continue safely by keeping the core at a constant temperature. In addition, the DCS automates control of the reactor's coolant level, the heat exchangers, cooling tower fans, waste flow, vessel seal, and many other important subsystems.

"The old systems were installed during the early '90s," said David Rowsell, engineering manager at ATR. "Though they were state-of-the-art at the time, over a decade later it became increasingly difficult to maintain these systems. Just as an example, part of the previous systems ran using Microsoft's Windows 3.1 operating system. Because Microsoft no longer supported this operating system, any new software installations required a major retrofit and valuable resource time."

The replacement DCS, which was purchased from Metso Automation -- the same supplier as the predecessor system -- offers the latest in operating system technology, making the system easier to maintain and update. The new system provides a flexible platform for future improvements.

ATR engineers testing the new instrumentation and control systems in March.

"The new DCS increases the system's speed and reliability," said Gary Bergeson, the project engineer who oversaw the DCS replacement project. "The redundant Ethernet network allows for more effective communication and troubleshooting capabilities."

Console display system and annunciator system

The CDS is the interface system for displaying information from the reactor's data acquisition system, which continuously monitors over 500 points of data during reactor operation. The annunciator system provides critical alarms to the reactor operators and archives the reactor's sequence of events for future reference. Should any of the reactor's systems function in a way other than as expected, the monitoring CDS displays the system status while the annunciator system alerts the operator to the condition.

"From a human factors standpoint, both of the replacement systems offer important benefits," said Kurt Fielding, the project engineer who oversaw the CDS/annunciator replacement. "The CDS offers enhanced navigation capabilities, making it easier for operators to access information, while the annunciator system went from 9 outdated light boxes to four 52-inch LCD screens with color-coded alarm displays."

Both the CDS and annunciator systems were purchased from Rolls-Royce, a prominent contributor to the commercial nuclear industry. The systems were designed with an eye toward the future—they remain open enough to incorporate future improvements and system updates. For example, the annunciator system now offers a greater number of alarm points and allows for future expansion.

Successful testing and installation practices

All three of the ATR's replacement instrumentation and control systems have been operating since March. This success is a direct result of the project team's rigorous planning, designing and testing.
"This was a project that went right from the start," said Bill Steele, the lead project manager for all of the system replacements at ATR, who noted the project came in under budget. "Our team successfully planned and executed a digital instrumentation and control system project that could be used as a model for future projects in the nuclear industry."

While much of the replacement project's success can be attributed to excellent planning and adherence to schedules, the critical nature of these systems demands more than good project oversight. The engineering teams spent two years working with the system designers to test all three systems in software test beds that duplicated the reactor's response.

"Between the three systems there are literally hundreds of thousands of data points and attributes that must be processed for safe reactor operation," said Bergeson. "The simulator testing at the lab's training facilities allowed us to resolve many replacement issues before plant installation. Once the systems were installed and back online, our operation tests encountered far fewer problems than typically seen in installations of this size."

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